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Review on Solar Chimney Ventilation

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ABSTRACT

Proper ventilation in one of the primary requirements of any domestic or commercial buildings. The conventional method employs usage of air conditioning or air-cooling systems which requires high power consumption. The solar driven ventilation systems can be used in buildings which doesn't require any external power. The current research reviews various researches conducted in improving system of passive ventilation along use of phase change material as energy storage system. Passive design of buildings does not use the electrical and mechanical systems in providing comfortable indoor environment.

KEYWORDS: *Passive ventilation, PCM, Thermal energy*

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1. INTRODUCTION

Globally the issue of the Energy crisis is becoming one of the most challenging problems. 40% or more of the consumed energy is because of the buildings [1]. People are and always look for improving the conditions inside their homes. Tropically hot countries are worried to keep their place cool and cold countries wish to keep their places warm. The characterization of energy that is present worldwide can be done as per the depleting energy resources as well as the rise in the expenses as well as environmental effects, with the demands increasing everyday are also presented. British Petroleum (BP), The "Inter-governmental Panel on Climate Change" (IPCC), and the "International Energy Agency" (IEA) classifies Buildings, Agriculture, Industry, and Transport, as the major energy consumption sectors in the whole world. The Working Group III associated with Intergovernmental Panel on Climate Change considers the Industry is the Biggest power-consuming sector, while the Building sector including Residential, Public, and Commercial are the 2nd largest power-consuming sector. Design or technological featured formed for providing cooling to the buildings with or without using a minimum amount of energy is known as Passive Cooling [2] these are used for improving the effectiveness of energy [3]. Whenever power consumption occurs, passive cooling methods are small set alongside the consumed cooling compared to active methods of cooling [2,3]. Further, it is often run on energy sources that are highly renewable [3]. Passive techniques of cooling are the most important for building cooling. Successful passive cooling designs used in the buildings require efficient knowledge regarding the patterns of airflow around a building as well as the effect other buildings in the neighbourhood have on it. Different types of Passive cooling methods are derived based on the internal gain of heat, transfer of heat in an envelope form along with transfer of heat occurring in outdoor and indoor air mixed of them.

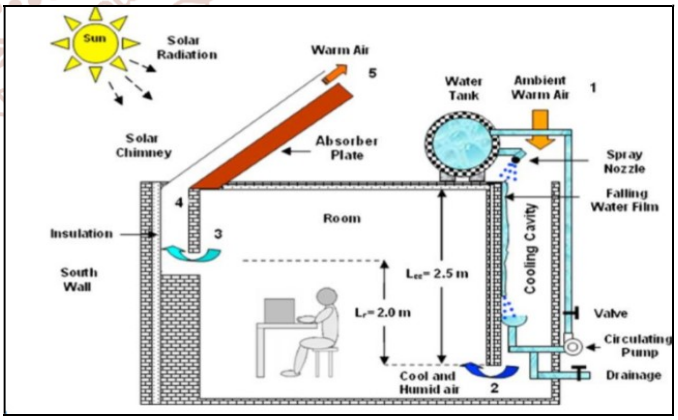

Figure 1: Schematic of solar chimney [4]

Solar chimney mainly uses the technology which working on buoyancy principle, solar radiation passes through the glazed part of solar chimney part and walls of SC gets heated. Inside air temperature of the solar chimney (SC) channel rises and if the temperature difference is high enough, then the stack effect drives the air from interior of the building and the exhaust air is replaced by fresh air this increases ventilation rate inside room and reduces inside temperature of the room and the heat is carried out through convective cooling principle [4].

2. LITERATURE REVIEW

Several researchers have studied the different parameters that affect the performance of solar chimney (SC). Computational Fluid Dynamics (CFD) analysis done by Chung et al. [5] shows optimum values of parameters which affects performance of SC. Researcher found that optimum air width gap ranges from 0.6m to 1.0m, length of chimney varies from 1.5m to 2m and induced air speed from .04m/s to 0.22m/s. Previous experimental study shows that Ventilation rate increases by 24% and it also shows that at air gap 10cm when the angle increases from 15 to 45° [6].

Alzaed et al. [7] shows by experimental study that air gap 5cm achieves better ventilation compared with 10cm air gap. Tongbai et al. shows by CFD model that at 6° channel expansion, flow ventilation increases by 90%. Solar chimney gives better cooling performance when integrated with evaporative cooling cavity which maintains the air temperature of 27.31°C to 31.1°C and optimum evaporative cooling cavity length found 2m [8]. Figure shows the integrated system with acceptable range for ventilated building. The integrated solar chimney and Evaporative Cooling Cavity (ECC) and standard acceptable limit of building comfort at different climate conditions [8, 9].

Li et. al. (2004) [10] studied the daylighting characteristics and usage of energy for the residential flats who face huge obstructions in the sky through computer simulations in Honk Kong. The key parameters they have analyzed for the daylighting performance in daylight factor, as well as Illuminance level terms and they, concluded limits for external obstructions so that you can satisfactorily achieve internal daylighting levels.

Analysis of the lighting power required for enhancing the illumination within a classroom. Poor-quality lighting is the main disadvantage of this technology [11,12]. In this connection combined thermal and lighting analysis has to be carried out. The most important parameters that to be considered at the early stages of optimization are the area of glass, shading properties and control [13-17]. Many researchers have performed a detailed analysis of shading and concluded that on average, the indoor temperature has been reduced by 3^{o}C

Roos et al. [18] examined its impact associated with the angle of incidence of radiations from the sun in terms of optical properties of windows controlled by the sun.

Nostell [19] conducted a wide experimental campaign on different coatings and presented the results of it, while the three-layer systems optical property on the substrates of glass is measured by

Durrani et al. [20]. Many researchers have analyzed the modeling of CFS: “Complex Fenestration Systems” which includes Translucent materials, solar control films, shading devices and multi-layer glass panes.

The HT of glazing with multiple layers and the selective coating is modeled by Alvarez et al. [21], although, the pros with respect to cooling and lighting energy consumptions in buildings by making use of films that are controlled by the sun is evaluated by while Li et al. [22]. Another model was developed by Maestre et al. [23] for the optical properties dependent on the angle of glazed coating, even though, Parekh and Laouadi [24,25]came up with CFS based optical models working on the distribution functions of bidirectional optical properties.

The present studies by Visser and Bakker [26] reviled a larger utilization of glazing controlled by the sun in EU nations could dodge the emanation of as much as 80million tons of carbon dioxide, that speaks to 25% of the objective built up in 2020 for saving energy by European Commission.

PCM is developing innovations that comprise microcapsules made up of a blended wax, paraffin, and other material of low melting point which has a prime objective on a building, which will store the heat which will, in turn, works as a free system for cooling [27-30]. The general principle of Phase Change Materials is to change the phase either Liquid to gas, Solid to Solid, or Solid to Liquid [31-35] which will store the latent heat and release as and when required. The temperature variation of these materials is in a limited range as the stored heat is latent [31-35]. In general, Phase Changing Materials could be linked to all the components and types of building envelopes, however, the characteristics and configurations will have its unique feature for different application areas. Another explained incorporation of Phase Changing Materials in the building was presented by Pasupathy et al. [36] along with many techniques used for containing them to manage thermally in both commercial and residential buildings.

Khalifa et al. [44] came up with a numerical model and worked on simulating the working of 3thermal storage walls all with different materials: ancient concrete, paraffin wax and CaCl26H2O hydrated salt in Iraq’s hot climatic conditions. Results of these numerical simulations depicts that so as to take care of a person's comfortable zone of temperature a desired minimum thickness of this wall ought to be Eight (8) cm for hydrated salt CaCl2 6H2O, Five (5) cm for paraffin wax, and 20cm in case of ancient concrete, an 8cm thick wall of CaCl26H2O hydrated salt will have the minimum number of fluctuations in the indoor temperature levels.

As per Sharma et al. [45], no such usage of “direct immersion” and “micro-encapsulated PCM” was a success in the commercial market. Presently an effective technique for immersing is the “microencapsulated PCM” into the material of building. The main idea behind “micro-encapsulated PCM” in encapsulating the membrane or the polymers where the dimension of every “micro-capsule” generally is just a few mm. Such an effective method of micro-encapsulation of PCM avoids directly immersed PCM or the macro-encapsulated shortages, like the matter of hard maintenance, leakage, shape distortion, and poor handling.

3. CONCLUSION

The review presents the application and feasibility of renewable source of energy for achieving passive ventilation. The use of solar chimney is feasible method for achieving ventilation in buildings. The thermal energy from sun can be stored using phase change material. Solar chimney gives better cooling performance when integrated with evaporative cooling cavity which maintains the air temperature of 27.31°C to 31.1°C

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